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ABSTRACT *

The purpose of this study was to relate Piaget-type tests to Stanford-Binet Mental Age and IQ, to IQ on the California Test of Mental Maturity, and to performance on the Metropolitan Achievement Test. Subjects were 143 children of bright, average, and retarded psychometric abilities; bright and average children were chronologically aged five to seven years, while retarded subjects were mentally aged five to seven years and chronologically aged six to twelve years. Fifteen Piaget-type tasks were individually administered in three sessions. Results indicated that although Piagetian and psychometric assessments are somewhat related, Piagetian measures represent some aspects of intelligence and achievement which are not included in standardized assessments currently used in schools. For another analysis of these data, see SE 016 419. (DT)

Relationships among Piagetian, Achievement,
and Intelligence Assessments¹

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This study is concerned with the empirical relationships among the theoretically different Piagetian and psychometric assessments of intelligence and school achievement.

Two important differences can be drawn between psychometric and Piagetian views of intelligence. First, psychometric assessments of intelligence are based on individual differences. In contrast, Piaget's notion of intelligence rests on individual developmental changes over time. Second, psychometric tests do not make the distinction which Piaget (1969) and Sinclair (personal communication) make among the sources and modes of structuring three aspects of intelligence: physical knowledge, logico-mathematical knowledge, and social knowledge.²

¹Paper presented at the annual meeting of the American Educational Research Association, New Orleans, March 1, 1973. The author wishes to thank Dr. Constance Kamii for her valuable criticisms and suggestions on an earlier draft of this paper.

²Physical knowledge is knowledge of the physical world which the child constructs by acting on objects and finding out how objects react (for example, things fall when one lets go of them in mid-air). Logico-mathematical knowledge, in contrast, does not come from the external world, but is constructed by the individual and imposed on objects (for example, number is not in objects, but is constructed by the mental action of grouping objects). Social knowledge (or social-arbitrary knowledge, as Kamii and I prefer to call it) is made by people and can only be learned from people (for example, the fact that Halloween is on October 31, and the fact that a pencil is not called a "blix").

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Standardized school achievement measures of knowledge differ in a very basic way from Piagetian measures of knowledge. School achievement tests were developed to assess how much curriculum content and skills a pupil has learned. In general, the idea behind achievement tests (and the curricula they represent) is that all knowledge is socially transmitted. This is quite in contrast to the Piagetian distinction of different sources of the three aspects of knowledge. From the Piagetian perspective, only social-arbitrary knowledge is learned through social transmission. Piaget emphasizes that physical and logico-mathematical knowledge cannot be socially transmitted but must be constructed by the child through his own mental actions on objects. Learning physical or logico-mathematical knowledge through social transmission can only be superficial verbal learning without real understanding.

Piagetian tasks assess the development of the child's knowledge of the physical world and his logico-mathematical knowledge, and provide information about his general cognitive structure. Thus, they are not assessments of how many right answers a child can give to specific questions, but are assessments of kinds of wrong answers as well. Piaget's research and theory indicate that a child must go through many stages of being wrong before he constructs adult-level knowledge and intelligence, and some wrong answers are more advanced developmentally than others.

Thus, Piaget's view of achievement is much broader than that reflected by school achievement tests. In the larger sense, he views the development of knowledge and the development of intelligence as the same. In the narrow, psychometric sense of achieving

right answers to specific questions, Piaget (1964) points out that it is general cognitive development which makes specific achievement possible.

Piaget's research and theory of cognitive development have become widely respected in psychology and education. It is currently fashionable to claim that curricula are based upon or are influenced by his ideas. However, psychometric assessments of intelligence and achievement continue to be used alongside such curriculum claims. How can such divergent views of intelligence and achievement be reconciled? Should we expect Piagetian and psychometric notions to be comfortable bedfellows? The present study considers the following two questions, in an attempt to clarify the relationships among performance on Piagetian tests and standardized tests of intelligence and achievement:

1. Is performance on Piaget-type tests simply another reflection of general intelligence assessed by psychometric tests? Specifically, how does performance on Piaget-type tests relate to Stanford-Binet Mental Age (MA) and the Intelligence Quotient (IQ), and to IQ on the California Test of Mental Maturity (CTMM)?
2. Does specific school knowledge also reflect the general knowledge found in performance on Piaget-type tests? Specifically, how does performance on Piaget-type tests relate to performance on the Metropolitan Achievement Test (MAT)?

Method

Subjects

Ss were 143 middle-class white children, of bright, average, and retarded psychometric abilities (measured by performance on

the Stanford-Binet Intelligence Test) enrolled in the public schools of Champaign, Illinois. Bright and average children were chronologically aged 5 to 7 years. Retarded Ss (including some pupils in Urbana and Saint Joseph, Illinois) were mentally aged 5 to 7 years and chronologically aged 6 to 12 years. Table 1 shows the distribution and characteristics of the sample.

Procedure

Fifteen Piaget-type tasks¹ were individually administered in three sessions totalling about two hours, as follows:

- Session 1: Guessing Game
Conservation of Mass
Sibling Egocentrism
Left-Right Perspective
Constancy of Generic Identity
Class Inclusion
- Session 2: Conservation of Number
Constancy of Sex Identity
Conservation of Mass in the context of the ring-segment illusion (Jastrow effect)
Dream Interview
Conservation of Length
- Session 3: Length Transitivity
Conservation of Liquid
Magic Interview
Object Sorting

Scores on the California Test of Mental Maturity and the Metropolitan Achievement Test were obtained from school records and interpolated for time of Piagetian testing.

Analysis

A Guttman scale was constructed for each of the Piaget-type tasks which met Green's (1956) criterion of an Index of Consistency greater than .50. Each scale also met Kohlberg's (1963) criteria

¹Tasks and scoring are described in detail in DeVries, Rheta, "Evaluation of Cognitive Development with Piaget-Type Tests: Study of Young Bright, Average, and Retarded Children" Final Report to Illinois Department of Program Development for Gifted Children, ERIC/ECE, Urbana, Illinois.

for developmental sequentiality. That is, mean scale scores increase with age, success on each scale item increases with age, and the sequence of items is justified with a logical rationale based on Piaget's theory. Each S was assigned a scale score on each task, and these were factor analyzed, using a principal components analysis, with both orthogonal and oblique¹ rotations.

Two sets of two factor analyses were performed. The first set of two analyses included 122 Ss and was performed on only Piagetian and Stanford-Binet data. The second set of two analyses was performed on a subsample of 50 Ss for whom the additional information was available. The two sets of analyses were performed with the following combinations of variables:

Factor Analysis Set 1

- a. Stanford-Binet IQ, Piagetian tasks (N=122)
- b. Stanford-Binet MA, Piagetian tasks (N=122)

Factor Analysis Set 2

- a. Stanford-Binet IQ, Piagetian tasks, CTMM Language and Non-Language IQ, and MAT subscores (N=50)
- b. Stanford-Binet MA, Piagetian tasks, CTMM Language and Non-Language IQ, and MAT subscores (N=50)

In Set 1, the two analyses differ only in that in Analysis 1a, S-B IQ is included, and in Analysis 1b, S-B MA is used. Similarly, Factor Analysis 2a includes S-B IQ, and 2b includes S-B MA.

¹The oblique rotation permits factors to be dependent. Piagetian tasks would be assumed to be related and the oblique rotation was judged necessary in order to ascertain whether the restriction of orthogonality (independence) of factors was distorting the factor picture.

Results

For all four analyses, the oblique rotations generally revealed nearly identical factors to those of the orthogonal rotations, and the factors can thus be said to be fairly independent. Therefore, these results focus on the outcome of orthogonal rotation.

Factor Analysis Set 1. When only Piagetian variables were included with either S-B IQ or MA, three main factors emerged: a first conservation factor, accounting for one-third of the variance, a third identity factor closely related to the conservation factor ($r=.36$), and a second factor containing most of the remaining Piagetian variables and either S-B MA or IQ. Tables 2 and 3 show these factor matrices. It should be noted that three tasks (Sibling Egocentrism, Length Transitivity, and Object Sorting) from two other weak and unimportant factors. The factor structure revealed by this set of analyses is that against which Factor Analysis Set 2 must be validated, since Set 2 is performed with a much smaller sample.

Factor Analysis Set 2. These analyses were performed for the subsample of 50 Ss (consisting of bright and average 6- and 7-year-olds) for whom scores on the MAT and CTMM were available. Results are shown in Tables 4 and 5.

These analyses yielded essentially the same grouping of Piagetian variables found for the larger sample. The conservation and identity groupings were especially stable, and minor differences involved tasks with very small variance.

Table 4 shows that for Analysis 2a (with S-B IQ), six factors emerged which accounted for 71 percent of the total variance. The

first conservation factor accounted for one-third of the variance (with minor loadings of S-B IQ and the two identity tasks). The second factor included CTMM Language and Non-Language IQ, Left-Right Perspective, Class Inclusion, and Magic (with minor loadings of S-B IQ and Ring Segment Conservation). The third factor was defined by MAT and Dream, and the fourth included S-B IQ and Length Transitivity. The fifth factor included the two identity tasks and Object Sorting, and the final factor was defined by Guessing Game.

The first conservation factor was related to the second CTMM factor ($r=.33$), due primarily to the high loading of Ring Segment Conservation on both factors. The second CTMM factor was related to the MAT factor ($r=.34$), due primarily to the moderate loading of CTMM variables on the MAT factor and to MAT Arithmetic's moderate loading on the CTMM factor.

Table 5 shows that the results for Analysis 2b (with S-B MA) are essentially the same. The main difference in the factor picture is that S-B MA loads on what was the second factor in Factor Analysis Set 1, making it the strongest factor accounting for one-third of the variance. Conservation, identity, and achievement factors reappear in essentially the same form, and Length Transitivity forms a trivial final factor.

Discussion

This study supports an earlier factor-analytic finding by Kohlberg and DeVries (in press). In that study of 67 bright and average 6-year-olds, eleven psychometric tasks from individual tests of intelligence defined a factor separate from two other factors defined by Piagetian tasks.

These results (illustrated in Figure 3) indicate that although Piagetian and psychometric assessments are somewhat related, Piagetian measures represent some aspects of intelligence and achievement which are not included in standardized assessments currently used in schools. The question is whether or not these (and other Piagetian measures) would be of any use to educators. Since school achievement bears no relationship to performance on Piagetian tasks, it would seem that Piagetian measures offer nothing to educators. However, if schools were to broaden the scope of their curriculum objectives (as suggested by Kohlberg and Mayer, 1973) to include both academic content and general development, Piagetian tasks would complement currently used tests of intelligence and achievement.

In summary, this study opens again the question of how our assessment techniques relate to our educational objectives. It is clear that by limiting evaluation to psychometric assessments of intelligence and achievement, a large part of development is missed. Should education be concerned with development as a whole?

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TABLE 1

MEAN CHRONOLOGICAL AGE, MENTAL AGE, AND IQ OF BRIGHT,
AVERAGE, AND RETARDED SUBJECTS IN STUDY 11 (N=143)

Age Group	Character- istics	Bright			Average			Retarded ^a		
		Boys	Girls	All	Boys	Girls	All	Boys	Girls	All
5	N	8	8	16	9	8	17	8	5	13
	CA ^b	5-5	5-8	5-7	5-6	5-6	5-6	7-10	7-4	7-8
	MA ^b	6-10	7-5	7-2	5-10	5-9	5-9	5-6	5-3	5-5
	IQ	130	133	132	108	105	106	69	67	68
6	N	8	8	16	8	9	17	8	8	16
	CA ^b	6-6	6-6	6-6	6-7	6-5	6-6	8-6	8-9	8-7
	MA ^b	8-2	8-2	8-2	6-10	6-11	6-10	6-4	6-5	6-5
	IQ	129	129	129	104	107	105	74	72	73
7	N	8	8	16	8	8	16	8	8	16
	CA ^b	7-7	7-7	7-7	7-9	7-7	7-8	9-11	10-1	10-0
	MA ^b	9-8	9-9	9-9	7-11	7-11	7-11	7-5	7-6	7-6
	IQ	130	130	130	101	105	103	75	74	75
Mean All Ages	N	24	24	48	25	25	50	24	21	45
	CA ^b	6-6	6-7	6-7	6-7	6-6	6-6	8-9	8-11	8-10
	MA ^b	8-3	8-5	8-4	6-10	6-10	6-10	6-5	6-7	6-6
	IQ	130	131	130	104	105	105	72	72	72

^aAge group classification for this group is mental age, rather than chronological age.

^bYears and months.

Figure 1

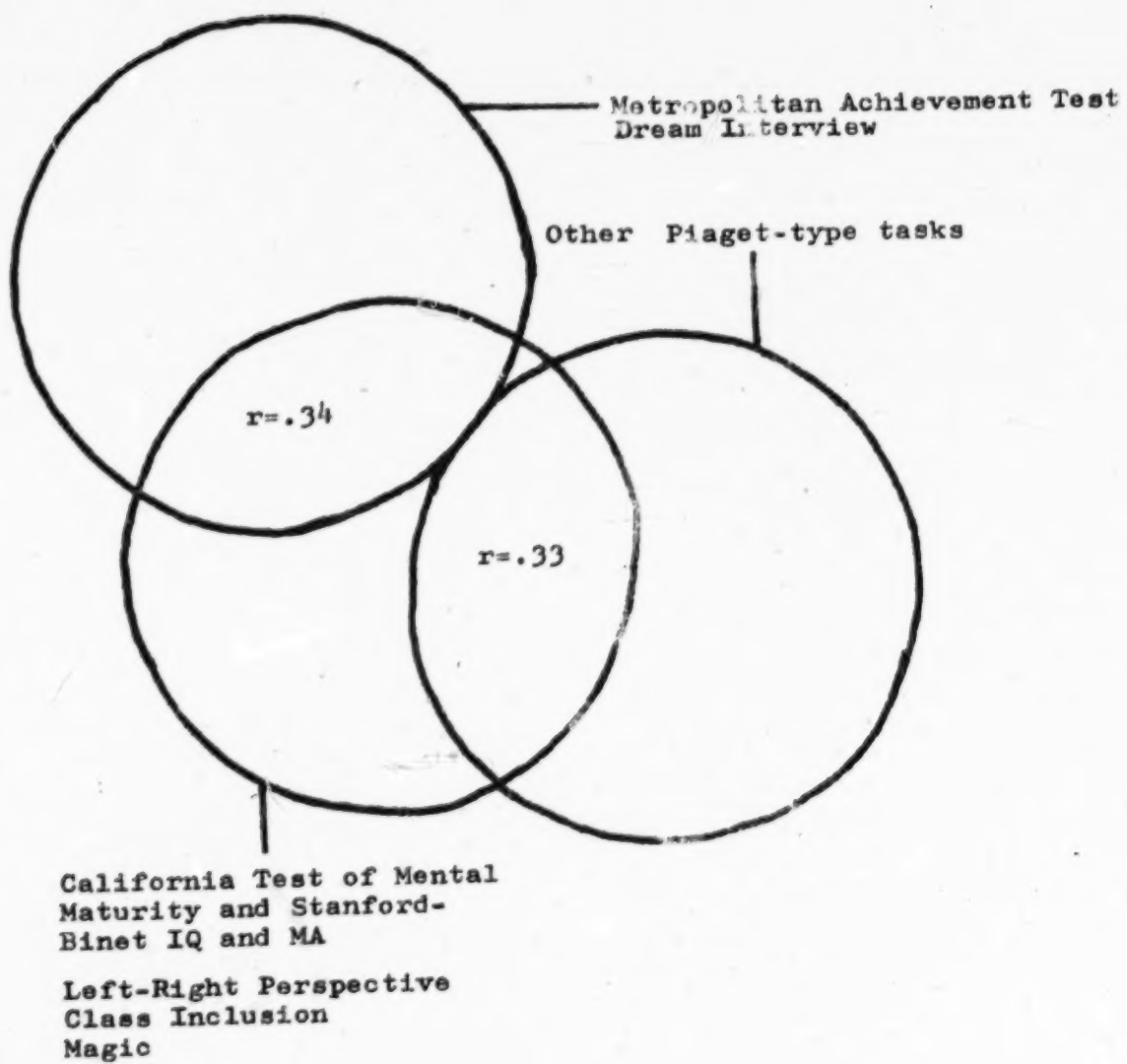


Table 2

Factor Matrix¹ Resulting from Varimax Rotation of Stanford-Binet Mental Age and Piagetian Variables
(N=50)

	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>	<u>Factor 4</u>	<u>Factor 5</u>
Percent of Variance	34.4%	11.1%	8.0%	7.3%	6.7%
Accounted for					
Stanford-Binet Mental Age	0.28	<u>0.79</u>	0.25	0.08	0.10
Guessing Game	0.29	<u>0.51</u>	-0.09	<u>0.42</u>	-0.11
Sibling Egocentrism	0.12	0.21	0.14	0.18	0.82
Generic Identity	0.22	0.14	<u>0.85</u>	0.08	0.06
Left-Right Perspective	-0.04	<u>0.76</u>	-0.14	-0.13	0.05
Mass Conservation	<u>0.79</u>	0.03	0.00	-0.03	0.22
Number Conservation	<u>0.84</u>	0.14	0.16	0.09	-0.14
Lex-Role Identity	0.19	0.16	<u>0.86</u>	-0.01	0.02
Class Inclusion	0.05	<u>0.68</u>	0.25	0.02	0.00
Liquid Conservation	<u>0.80</u>	0.14	0.15	0.16	0.19
Length Conservation	<u>0.76</u>	0.13	0.25	-0.11	-0.09
Length Transitivity	0.04	<u>0.36</u>	0.12	<u>0.43</u>	-0.53
Logic	0.18	<u>0.56</u>	<u>0.42</u>	-0.02	0.10
Ring Segment Conservation	<u>0.58</u>	<u>0.47</u>	<u>0.33</u>	-0.01	0.01
Object Sorting	-0.02	-0.09	0.05	<u>0.90</u>	0.12
Dream	<u>0.38</u>	<u>0.53</u>	<u>0.31</u>	<u>0.05</u>	-0.11

¹ The highest loading of a variable is underlined with a solid line. Where secondary loadings are $>.40$, they are underlined with a dotted line.

Table 3

Factor Matrix¹ Resulting from Varimax Rotation of Stanford-Binet IQ and Piagetian Variables
(N=50)

	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>	<u>Factor 4</u>	<u>Factor 5</u>
Percent of Variance	32.4%	10.8%	8.3%	7.3%	6.7%
Stanford-Binet I.Q.	0.23	0.58	0.04	0.33	0.19
Classifying Game	0.29	0.53	-0.05	0.39	-0.08
Classifying Egocentrism	0.12	0.19	0.18	0.15	0.85
Generic Identity	0.22	0.06	0.86	0.11	0.07
Left Right Perspective	-0.04	0.77	-0.04	-0.21	0.07
Class Conservation	0.79	0.02	0.01	-0.04	0.22
Number Conservation	0.84	0.16	0.17	0.10	-0.13
Box-Cube Identity	0.19	0.09	0.86	0.01	0.04
Class Inclusion	0.05	0.64	0.33	0.04	0.01
Fluid Conservation	0.80	0.05	0.19	0.14	0.17
Length Conservation	0.76	0.10	0.26	-0.09	-0.09
Length Transitivity	0.07	0.40	0.13	0.46	-0.47
Logic	0.19	0.48	0.50	-0.06	0.07
Class Segment Conservation	0.58	0.46	0.36	0.01	0.05
Object Sorting	-0.03	-0.08	0.04	0.86	0.12
Stream	0.34	0.48	0.38	0.01	-0.12

¹The highest loading of a variable is underlined with a solid line. Where secondary loadings are $>.40$, they are underlined with a dotted line.

Table 4

Factor Matrix¹ Resulting from Varimax Rotation of Stanford-Binet Mental Age, Piagetian Variables, California Test of Mental Maturity Non-Language and Language I.Q., and Metropolitan Achievement Test Subscores

(N=50)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Percent of Variance	35.2%	12.5%	7.8%	5.8%	5.2%	5.0%
Accounted for						
Stanford-Binet Mental Age	<u>0.79</u>	0.18	<u>0.36</u>	-0.09	-0.02	0.22
Guessing Game	-0.01	0.17	-0.03	0.16	<u>0.87</u>	0.15
Sibling Egocentrism	0.13	<u>0.57</u>	0.24	0.01	-0.17	0.16
Generic Identity	0.28	<u>0.48</u>	0.13	<u>0.64</u>	0.07	0.13
Left-Right Perspective	<u>0.54</u>	0.13	0.23	-0.27	0.23	0.11
Mass Conservation	<u>0.37</u>	<u>0.73</u>	0.16	-0.01	0.23	-0.24
Number Conservation	0.18	<u>0.80</u>	0.01	0.12	<u>0.36</u>	0.15
Sex-role Identity	0.24	<u>0.52</u>	-0.00	<u>0.63</u>	0.04	0.19
Class Inclusion	<u>0.72</u>	-0.01	0.16	0.18	-0.21	0.05
Liquid Conservation	<u>0.67</u>	<u>0.75</u>	0.22	0.05	0.19	-0.25
Length Conservation	0.07	<u>0.77</u>	0.03	0.12	-0.13	0.13
Length Transitivity	0.10	<u>0.03</u>	0.26	0.01	0.18	<u>0.85</u>
Magic	<u>0.74</u>	0.21	0.06	<u>0.37</u>	0.03	-0.14
Ring Segment Conservation	<u>0.53</u>	<u>0.57</u>	0.03	0.09	0.06	<u>0.34</u>
Object Sorting	-0.28	-0.10	<u>0.30</u>	-0.06	0.19	-0.18
Dream	0.41	0.19	<u>0.61</u>	0.10	0.27	0.15
M.A.T. Word Knowledge	<u>0.24</u>	0.30	<u>0.76</u>	0.14	-0.06	0.13
M.A.T. Word Discrimination	0.20	<u>0.29</u>	<u>0.78</u>	0.12	-0.20	0.20
M.A.T. Reading	0.17	-0.02	<u>0.73</u>	0.00	-0.05	0.07
M.A.T. Arithmetic	<u>0.39</u>	0.04	<u>0.74</u>	0.00	0.23	-0.12
C.T.M.M. Non-Language	<u>0.80</u>	0.14	<u>0.31</u>	0.02	-0.02	-0.02
C.T.M.M. Language	<u>0.82</u>	0.12	0.27	-0.08	0.12	0.07

¹The highest loading of a variable is underlined with a solid line. Where secondary loadings are $> .40$, they are underlined with a dotted line.

Table 5

Factor Matrix¹ Resulting from Varimax Rotation of Stanford-Binet I.Q., Piagetian Variables, California Test of Mental Maturity Non-Language and Language I.Q., and Metropolitan Achievement Test Subscores

(N=50)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Percent of Variance Accounted for	35.2%	12.5%	7.8%	5.8%	5.2%	5.0%
Stanford-Binet I.Q.	<u>0.33</u>	<u>0.47</u>	<u>-0.28</u>	<u>0.56</u>	<u>-0.01</u>	<u>-0.16</u>
Guessing Game	0.17	-0.03	-0.02	0.12	0.16	<u>0.88</u>
Spelling Egocentrism	0.56	0.12	0.23	0.19	-0.03	<u>-0.15</u>
Geometric Identity	<u>0.48</u>	<u>0.35</u>	0.12	0.16	<u>0.58</u>	<u>0.09</u>
Left-Right Perspective	<u>0.12</u>	<u>0.49</u>	0.29	0.09	<u>0.35</u>	0.27
Mass Conservation	<u>0.74</u>	0.07	0.18	-0.20	<u>-0.03</u>	0.21
Number Conservation	<u>0.80</u>	0.17	0.02	0.17	0.07	<u>0.38</u>
Sex-role Identity	<u>0.53</u>	<u>0.31</u>	-0.03	0.22	<u>0.57</u>	0.06
Class Inclusion	-0.01	<u>0.74</u>	0.19	0.07	<u>0.07</u>	-0.17
Liquid Conservation	0.78	0.05	0.23	-0.17	0.06	0.14
Length Conservation	<u>0.76</u>	0.08	0.01	0.19	0.09	-0.13
Length Transitivity	-0.01	0.02	0.24	0.86	-0.02	0.20
Magic	0.24	0.78	0.08	-0.03	0.26	0.02
Ring Segment Conservation	<u>0.55</u>	<u>0.51</u>	0.04	0.40	-0.01	0.08
Object Sorting	-0.07	-0.20	0.26	<u>-0.15</u>	<u>0.68</u>	0.15
Dream	0.19	<u>0.34</u>	0.63	0.21	-0.09	0.25
A.A.T. Word Knowledge	0.30	<u>0.20</u>	<u>0.76</u>	0.16	0.10	-0.06
A.A.T. Word Discrimination	<u>0.29</u>	0.16	<u>0.77</u>	0.28	0.14	-0.23
A.A.T. Reading	-0.02	0.14	<u>0.73</u>	0.06	0.14	-0.05
A.A.T. Arithmetic	0.06	<u>0.35</u>	<u>0.77</u>	-0.07	-0.01	0.20
C.T.M.M. Non-Language	0.15	<u>0.76</u>	0.36	0.05	-0.07	-0.01
C.T.M.M. Language	<u>0.12</u>	<u>0.77</u>	0.32	0.11	-0.18	0.14

¹The highest loading of a variable is underlined with a solid line. Where secondary loadings are $> .40$, they are underlined with a dotted line.